

**BEFORE
THE PUBLIC SERVICE COMMISSION OF
SOUTH CAROLINA**

DOCKET NO. 2019-290-WS

In the Matter of:

**Application of Blue Granite Water
Company for Approval to Adjust
Rate Schedules and Increase Rates**

**REBUTTAL TESTIMONY OF
BRYCE MENDENHALL FOR
BLUE GRANITE WATER COMPANY**

1 **Q. PLEASE STATE YOUR NAME, PRESENT POSITION, AND BUSINESS**
2 **ADDRESS.**

3 A. My name is J. Bryce Mendenhall. I am Vice President of Operations for Blue Granite Water
4 Company ("BGW" or "Company"), Carolina Water Service, Inc. of North Carolina in
5 North Carolina, and Tennessee Water Service, Inc. in Tennessee, all of which are
6 subsidiaries of Corix Regulated Utilities, Inc. ("CRU"). My business address is 4494
7 Parkway Plaza Boulevard, Suite 375, Charlotte, North Carolina 28217.

8 **Q. ARE YOU THE SAME J. BRYCE MENDENHALL WHO SUBMITTED DIRECT**
9 **TESTIMONY ON BEHALF OF BLUE GRANITE WATER COMPANY IN THIS**
10 **PROCEEDING?**

11 A. Yes.

12 **Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?**

13 A. The purpose of my testimony is to respond to the testimony of ORS Witnesses Maurer and
14 Bickley and Consumer Advocate Witness Morgan. I will also address certain issues that
15 arose during night hearings conducted recently for this proceeding.

16 **Q. HAVE YOU REVIEWED THE FILED DIRECT TESTIMONY OF THE ORS, THE**
17 **CONSUMER ADVOCATE, AND OTHER INTERVENORS?**

18 A. Yes.

19 **I. NON-REVENUE WATER**

20 **Q. ORS WITNESS MAURER PROPOSES AN ADJUSTMENT TO DISALLOW**
21 **RECOVERY OF PURCHASED WATER EXPENSES AND PURCHASED WATER**
22 **DEFERRALS FOR NON-REVENUE WATER LEVELS GREATER THAN 10%.**
23 **DO YOU AGREE WITH THIS ADJUSTMENT?**

A. No. First, to support its position, ORS relies upon a 4-page report from 1996 issued by the American Water Works Association (“AWWA”) Leak Detection and Water Accountability Committee. That report is outdated and its positions have been conclusively rejected by the AWWA itself in various capacities in subsequent years. More credible authorities on non-revenue water disallowances are (1) a November 2019 report issued by the AWWA Water Loss Control Committee, (2) a January 2020 report issued by the AWWA Water Loss Control Committee, and (3) the current edition of the AWWA’s Manual 36 on Water Audits and Loss Control Programs, issued in 2016.

The AWWA Water Loss Control Committee now rejects the use of a universal threshold for disallowing recovery of non-revenue water expenses:

AWWA recommended against setting loss reduction goals around a specific target such as “less than 10%”, recognizing that loss reduction targets are best tailored as system-specific goals for each water utility rather than a “one size fits all” approach.

AWWA recommends that the industry stop using percentage indicators . . . [T]here is still confusion as evidenced by:

- Inquiries received by AWWA from the regulatory community and other stakeholders seeking the “acceptable” water loss percentage level.
- Publications on water loss that refer to the “AWWA Standard of ___%” - the “standard” listed as anything from 5% to 20%. These misrepresentations, often derived anecdotally, come from technology and service providers, regulatory agencies, environmental groups, and water utilities. Since 2003, AWWA has recommended that it is best for utilities to set system-specific loss targets, and not use a prescribed one-size-fits-all number.

Additionally, percentage indicators like VPPI [Volumetric Percentage Performance Indicator] are not technically rigorous because they can be significantly influenced by parameters unrelated to NRW.

AWWA recommends that water utilities, regulatory agencies and other industry stakeholders discontinue use of a VPPI or “unaccounted-for” water percentage indicator.¹

In the January 2020 issue of Journal AWWA, the AWWA Water Loss Control Committee issued a report titled “Key Performance Indicators for Nonrevenue Water—AWWA’s 2020 Position,” which I have attached hereto as Mendenhall Rebuttal Exhibit No. 1. The report concludes as follows:

The traditional use of a single NRW percentage loss indicator, or “unaccounted-for” water percentage—which is imprecise—continues to bring more confusion than coherence to water loss assessments. This method arguably has never been successful in motivating sustained, measurable loss reductions.²

As suggested by the AWWA, ORS’s proposed 10% threshold is arbitrary, has no rational basis, and should be rejected by the Commission. Instead of using arbitrary percentage loss indicators, the AWWA’s Water Loss Manual states the following:

Thresholds for compliance should be based on well-founded rationales that yield actionable information and recognize benefit-cost analysis to evaluate alternative activities for achieving compliance, such as those described in this manual. Such rationales are preferred over arbitrary, less meaningful parameters like universal or percentage-based triggers. The method of calculation for the applicable parameters should be clearly stated.³

The Company is, in fact, implementing AWWA-recommended measures against non-revenue water, including reviewing existing data, validating water balance data and recommendations for data validation, preparing an AWWA water balance, making

¹ *Key Performance Indicators for Non-Revenue Water*, AWWA Water Loss Control Committee Report (Nov. 2019), available at <https://www.awwa.org/Portals/0/AWWA/ETS/Resources/WLCKPIReport%202019.pdf?ver=2019-11-20-094638-933> (emphasis original).

² *Key Performance Indicators for Nonrevenue Water—AWWA’s 2020 Position*, AWWA Water Loss Control Committee Report (Jan. 2020).

³ AWWA Manual 36 at 15 (4th Ed. 2016).

1 improvements for water loss control, and implementing field leak detection. Additionally,
2 the Company regularly reviews vacancy and zero consumption reports to aid in this
3 endeavor. In other words, the Company is taking proactive steps to reduce non-revenue
4 water consistent with AWWA recommendations, and should not be penalized based on an
5 arbitrary threshold that the AWWA has explicitly rejected.

6 **Q. ORS WITNESS MAURER STATES THAT “THE COMPANY EXPERIENCED A**
7 **LARGE INCREASE TO THE NUMBER OF SUBDIVISIONS WITH MORE THAN**
8 **10% NON-REVENUE WATER SINCE ITS LAST RATE CASE.” DO YOU**
9 **AGREE WITH THAT STATEMENT?**

10 A. No. The comparison made by Witness Maurer’s list of 21 systems in this proceeding to
11 the 3 systems identified in testimony by ORS in the last rate case is not apples-to-apples.
12 Of the 21 systems cited by Witness Maurer:

- 13 • 5 were partially supplied by Company-owned wells during the 12 months ended
14 11/30/2019,⁴ and an additional 4 systems were supplied partially by wells in the
15 last rate case’s Test Year, but have since transitioned to fully purchased water
16 supply.⁵ During the last rate case, such systems were excluded as it is not
17 determinable whether water losses are generated from the source wells or the
18 purchased supply interconnection.
- 19 • The River Hills/Lake Wylie system was excluded in the last rate case, as under the
20 prior York County franchise agreement BGWC customers were charged the actual

⁴ Stonegate (2 wells), Leon Bolt (1 well), Washington Heights (2 wells), Charleswood (3 wells), and Country Oaks (2 wells).

⁵ Farrowood, Foxwood, Hidden Lakes, and Peachtree Acres.

1 York County rate, and there was therefore no need to consider water loss in pro-
2 forma Purchased Water Expense.

- 3 • In its last rate case, it was determined that 2 systems noted here by Witness Maurer
4 had their data compromised by meter reader errors, and a billed consumption
5 adjustment was proposed instead of a water loss adjustment by ORS.

6 Additionally, the Company has improved its recordkeeping and data gathering, is now
7 better aware of the most problematic areas for non-revenue water, and is now better
8 equipped to implement system improvements to address non-revenue water. As discussed
9 in Company Witness Denton's testimony, the Company is engaged in the long-term
10 process of substantially improving Blue Granite's performance. This necessarily requires
11 that the Company know its systems better so that it can more strategically plan for asset
12 maintenance and capital investment. Blue Granite should not be penalized for engaging in
13 this process, which is ultimately to the benefit of customers.

14 **Q. ORS ADJUSTS PURCHASED WATER EXPENSE BASED ON THE COMPANY'S**
15 **NON-REVENUE WATER FIGURES FOR THE 12 MONTHS ENDED 11/30/2019.**
16 **IS THAT AN APPROPRIATE FIGURE FOR QUANTIFYING AND**
17 **DISALLOWING PURCHASED WATER EXPENSES?**

18 A. No. As noted earlier in my testimony, 5 of the systems listed by Witness Maurer were
19 served by Company wells during the 12-month period utilized, and therefore some of the
20 non-revenue water is attributable to the source wells and should not be used to quantify the
21 cost of non-revenue water from the purchased water supplier.

22 **Q. YOU STATE THAT THE AWWA RECOMMENDS AGAINST USING AN**
23 **ABRITRARY THRESHOLD TO MEASURE A UTILITY'S NON-REVENUE**

**WATER PERFORMANCE. IN THE ABSENCE OF ORS OR THE COMMISSION
USING A THRESHOLD, WHAT DO YOU RECOMMEND?**

A. I believe that the Company's non-revenue performance should be evaluated consistent with the AWWA's recommendations, including recognizing the benefit-cost analysis to evaluate alternative activities for achieving compliance. While the Company is taking measures to actively address non-revenue water, infrastructure investigations, repairs, and replacements can be extremely expensive, and these costs would be passed along to customers.

To assist in providing some perspective to the cost considerations, the below Table 1 summarizes the 16 systems listed by Witness Maurer not supplied partially by Company wells, and the estimated cost of a helium leak detection study to identify the extent of leaks in the distribution system. The estimated cost is based on a cost-per-linear foot as experienced by the Company's North Carolina affiliate in initiating similar studies in 2019. As shown, the leak detection studies alone would cost more than the annual cost of non-revenue water above ORS's threshold, without any consideration for the follow-up costs to repair or replace leaking water lines. It should also be noted that a leak detection study is not guaranteed to identify any and all water losses that lead to non-revenue water above a certain threshold, and therefore would not guarantee significant mitigation on its own, but such efforts would be an essential early step in addressing non-revenue water.

TABLE 1:

Subdivision	Non-Revenue Water Rate	Feet of Main	Connections at Test Year-end 6/30/2019	Non-Revenue Water Cost over 10%	Leak Detection Cost (\$0.59/ft)
WESTSIDE TERRACE	30%	9504	64	\$1,742.37	\$5,647.28

PEACHTREE ACRES	49%	10560	48	\$10,696.13	\$6,274.76
RIVER HILLS	14%	241658	4804	\$69,977.53	\$143,593.33
1-20	20%	180711	2419	\$107,973.68	\$107,378.59
ROLLINGWOOD	11%	24288	193	\$993.87	\$14,431.94
WATERGATE/ SPENCEPOINT/ MALLARD SHORES	17%	23676	143	\$2,454.46	\$14,068.29
WINDWARD POIN T- HARBOUR PLACE	13%	5280	111	\$1,794.28	\$3,137.38
DUTCHVILLAGE/ DUTCHCREEK	11%	4,850	17 9	\$906.49	\$2,881.87
DUTCHMAN SHORES	13%	17689	162	\$1,136.24	\$10,510.81
FARROWOOD	11%	7180	146	\$440.64	\$4,266.36
FOXWOOD	12%	18480	220	\$1,387.57	\$10,980.83
HIDDEN LAKES	36%	8800	46	\$5,559.32	\$5,228.97
CALHOUN ACRES	14%	9350	75	\$258.47	\$5,555.78
HILL AND DALE	53%	7570	67	\$11,108.55	\$4,498.10
CLEARVIEW	12%	7425	62	\$302.68	\$4,411.94
HIDDEN LAKE	18%	21450	71	\$1,603.57	\$12,745.60

A more reasonable approach than requiring all of a utility's systems to achieve a 10% non-revenue water target—and one that would be consistent with the AWWA's recommendations—would be to set goals for each system and to evaluate the Company's efforts towards reducing non-revenue water. In this vein, the Company is willing to accept ORS's recommendation that the Company engage a third-party to complete water audits for its systems. In light of the associated cost, the Company requests that the Commission authorize deferral treatment of the resulting third-party audit costs, and the accrual of carrying cost at the Company's authorized cost of debt, to facilitate recovery in the Company's next rate case. The system water audits performed would concentrate on the following tasks:

Task 1: Review of existing Water Audits and Water Audit Relevant Data

Task 2: Validation of Water Balance Data and Recommendation for Bottom-Up Data

Validation Tests

Task 3: Preparation of AWWA Water Balance:

Water Supplied	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	Non- Revenue Water
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorized Consumption	
			Customer Meter Inaccuracies	
			Data Handling Errors	
		Real Losses		

Task 4: Recommendations for Water Loss Control and Infrastructure

Task 5: Field Leak Detection

As discussed above, the AWWA's position, with which I agree, is that utilities should be evaluated based on the steps they are taking to reduce non-revenue water rather than be subject to an arbitrary one-size-fits-all threshold. I've identified that, in other jurisdictions, a variety of thresholds have been implemented, as noted in Table 2 below. Based on the above considerations for assessing non-revenue water per the AWWA, the cost to initiate loss mitigation efforts, and the standards used by various jurisdictions, the Company would propose a 20% non-revenue water threshold should the Commission deem a particular threshold is warranted in this proceeding.

State		Source
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	Water Loss Threshold	
Tennessee	20%	AWWA Manual 36 - Water Audits and Loss Control Programs, Water Loss Regulatory Approaches, Page 12
Pennsylvania	20%	Title 52, Section 65.20(4)
North Carolina	15%	Docket W-218, Sub 498, Order at 117, 12/18/2018
Florida	10%	Rule 25-30.4325(1)(e)
Wisconsin	25% for small utilities, 15% for large utilities	AWWA Manual 36 - Water Audits and Loss Control Programs, Water Loss Regulatory Approaches, Page 12

Q. YOU MENTION EVALUATING THE COMPANY’S EFFORTS TO ADDRESS NON-REVENUE WATER. HOW HAS THE COMPANY MADE STRIDES IN MITIGATING WATER LOSS SINCE ITS LAST RATE CASE?

A. In the Dutch Village/Dutch Creek neighborhood in Columbia, we identified and repaired a leak in February 2019, and we will continue to monitor that system and others for other leaks that may be occurring. The River Hills neighborhood in York and the I-20 / Brighton Forest neighborhood in West Columbia are our two most costly systems in terms of water loss. For River Hills, we installed AMI meters in 2019, which should help with leak identification and remediation, and we will continue to work with York County to ensure that the master meter showing system inflows at the interconnection is accurate. For Brighton Forest, we are taking similar measures. AMI meters are planned to be installed in 2020 and 2021, and we have requested that the vendor test the interconnection meter for accuracy. In summary, where it makes financial sense for our customers, we are taking proactive steps to address and reduce water loss at the lowest reasonable cost.

II. OTHER ISSUES

Q. CONSUMER ADVOCATE WITNESS MORGAN SUGGESTS THAT THE STORM RESERVE FUND IS NOT NECESSARY BECAUSE “A SIGNIFICANT PORTION

1 **OF [THE COMPANY’S] INFRASTRUCTURE IS BELOW GROUND.” DO YOU**
2 **AGREE?**

3 A. No. While it is true that our pipes are underground, the most significant of our
4 infrastructure in terms of cost and vulnerability to storm damage is our plants. Following
5 major storm events, the Company has experienced service disruptions due to temporary
6 power loss and damage to supply or treatment infrastructure, as well as main breaks, which
7 can cause low pressure and require boil water advisories. It can take from less than an hour
8 to several days to restore full service to customers depending on the nature of the damage
9 sustained to the Company’s systems. As discussed in more detail in Mr. DeStefano’s
10 testimony, the Storm Reserve Fund would be used to cover extraordinary storm restoration
11 costs beyond those included in the Company’s revenue requirement. Such costs would
12 include, for example, generator services necessary to restore service, damage assessments
13 and inspections, site preparation, and facilities repair.

14 **Q. AS RELATED TO THE COMPANY’S PROPOSAL RELATED TO PUMPING**
15 **CHARGES ASSOCIATED WITH PUMPING LETTS TANKS, ORS WITNESS**
16 **BICKLEY RECOMMENDS THAT CUSTOMERS BE PERMITTED TO SEEK**
17 **ALTERNATIVE SERVICE PROVIDERS. WHAT IS YOUR RESPONSE TO THIS**
18 **RECOMMENDATION?**

19 A. While this recommendation may sound good in theory, I am concerned that it could lead
20 to sanitary sewer overflows. When an interceptor or LETTS tank is full and in need of
21 pumping, it creates the potential for a sanitary sewer overflow or back-up into the
22 customer’s residence. A prompt response is therefore necessary to pump out the
23 interceptor tank in order to limit or prevent such overflows. A requirement that the

1 customer search for service providers, identify properly licensed and certified providers,
2 obtain quotes, and select a provider of their choice would prevent Blue Granite or its on-
3 call providers from acting immediately to pump an interceptor tank. This presents a health
4 risk to the environment, the public, and the customer. Further, the Company has assurance
5 that its providers will dispose of the pumped materials properly and in compliance with
6 applicable environmental laws and local ordinances. On the other hand, were the customer
7 to choose a “least cost provider,” such assurance may come into question.

8 **Q. ORS WITNESS BICKLEY DISCUSSES A 2007 CASE IN WHICH TOTAL**
9 **ENVIRONMENTAL SOLUTIONS, INC. (“TESI”) ENTERED INTO**
10 **AGREEMENTS WITH ITS CUSTOMERS RELATED TO THE MAINTENANCE**
11 **AND REPAIR OF GRINDER PUMPS TO SUPPORT THE PROPOSITION THAT**
12 **BLUE GRANITE’S CUSTOMERS COULD CHOOSE THEIR OWN LETTS TANK**
13 **PUMPING CONTRACTOR. IS THIS A REASONABLE COMPARISON?**

14 **A.** No, not in my opinion. In the case of TESI, Docket No. 2007-359-WS, the utility sought
15 Commission approval of an arrangement set forth in a consent agreement between itself
16 and the South Carolina Department of Health and Environmental Control (“DHEC”). The
17 checkered history of that situation—including the related DHEC proceeding, appeal, and
18 final agency decision—is explained in the application filed in that docket on September
19 27, 2007, in the Consent Agreement attached thereto, and in the testimony filed by TESI
20 witness Bill Schoening on January 24, 2008. The ultimate result was that TESI was to
21 attempt to enter into a 6-page contract with each of its customers—a contract that had been
22 negotiated between TESI and DHEC—that vested the customer with certain obligations,
23 including (1) ensuring adequate electrical power to the pump, (2) providing adequate pump

1 access to the utility, (3) not introducing into the sewer system non-biodegradable or
2 harmful products, including those specified by the Utility, (4) immediately notifying the
3 utility of a pump malfunction or spill, and (5) bearing the cost of any necessary repairs or
4 maintenance. Under the settlement agreement entered into in the proceeding, TESI was
5 also required to submit to DHEC a list of customers who refused to sign the contract.

6 In this case, there has been no prior proceeding with DHEC and no contract has
7 been developed with DHEC's input that would govern the parties' responsibilities. This is
8 a vitally important element to Blue Granite given the environmental risk of potentially
9 overflowing LETTS tanks and the need for prompt pumping. Ultimately, to accept ORS's
10 position of permitting customers to find their own pumping contractor, Blue Granite would
11 need assurances that such could be completed within a prompt timeframe and in a way that
12 was compliant with all applicable environmental laws and regulations. ORS's proposal
13 falls short of that.

14 **Q. ORS WITNESS MAURER RECOMMENDS THAT CUSTOMERS NOT BE**
15 **RESPONSIBLE FOR ANY COSTS ASSOCIATED WITH REPAIRING THE**
16 **CURRENT WHALING OF THE EQ BASIN. WHAT IS THE COMPANY'S**
17 **POSITION ON THIS ISSUE?**

18 A. First, the Company is pursuing remedies for this issue from the contractor and engineer
19 under the construction warranty. Second, because the Company has not requested any cost
20 recovery from customers related to the whaling of the basin liner, it is not an appropriate
21 topic for this proceeding and should not be pre-judged.

22 **Q. CUSTOMER SERVICE WAS AN ISSUE DISCUSSED BY CUSTOMERS AT THE**
23 **NIGHT HEARINGS FOR THIS PROCEEDING, INCLUDING HOLD TIMES AND**

**ABILITY TO HAVE ISSUES RESOLVED WITH THE COMPANY OVER THE
PHONE. CAN YOU PLEASE DISCUSS THESE ISSUES?**

A. First, the average hold time for customers calling the Company in 2019 was 1 minute and 3 seconds. Call-by-call hold times can vary based on the time of day, system issues and how busy the call center is at any given time, but we operate against a Target Average Speed of Answer Service Level of 80% of all calls answered within 60 seconds of entering queue. We recognize that the more customer service personnel we hire, the greater these costs will be for our customers, but I believe that an average hold time of 63 seconds strikes a reasonable balance. Further, most issues are resolved within 9 to 9.5 minutes, representing the average customer “treatment time.” Finally, 100% of the customers with an unresolved complaint were notified of their ability to contact ORS.

**Q. HOW DO EMERGENT ISSUES, SUCH AS OUTAGES OR MAIN BREAKS, GET
ESCALATED WHEN A CUSTOMER CALLS?**

A. For service-related inquiries, the Company’s standard is to respond to all emergency calls—such as water outages, sewer back-ups, main breaks, etc.—immediately. Contact center personnel are trained to ask the customer a series of questions to assist field personnel in their response. Once all pertinent information has been gathered by the contact center, a “field activity” (“FA”) is prepared and pushed out to the appropriate field staff for further investigation and intervention. After-hours emergency issues are handled by a third-party service and answered by a live agent. The agent records pertinent information including: (1) location; (2) contact information; and (3) service issue. The information is then relayed to the on-call operations technician through text, cell phone and/or email. If the on-call technician does not respond within 15 minutes, the next

1 designated manager/technician is contacted. The Company has multiple staff members
2 across the State serving in on-call status for after hour emergencies every day.

3 **Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?**

4 **A. Yes.**

Committee Report: Key Performance Indicators for Nonrevenue Water—AWWA's 2020 Position

AWWA Water Loss Control Committee

Key Takeaways

Water utilities use performance indicators in their efforts to control water loss.

Citing flaws in traditional percentage indicators for nonrevenue water, AWWA favors other indicators—some in development, some already in use.

AWWA outlines criteria for evaluating key performance indicators in its 2020 position statement.

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Since 2003, AWWA's Water Loss Control Committee (WLCC) has encouraged utilities and other stakeholders to assess and control water loss using the nonrevenue water (NRW) key performance indicators (KPIs) outlined in AWWA Manual of Water Supply Practices M36, *Water Audits and Loss Control Programs* (4th edition, 2016) and the associated Free Water Audit Software (FWAS; version 5.0, 2014).

However, on the basis of potential new indicators and a growing concern about the use of percentage indicators, the WLCC recently reviewed these KPIs, ultimately concluding that AWWA would no longer support NRW percentage indicators and would instead support adding two new KPIs—the loss cost rate and normalized water losses indicator—to AWWA's existing array of KPIs.

The process used to reach these conclusions and how they should be interpreted and used by utilities and other stakeholders is outlined in this report.

Background

Drinking water utilities are challenged by deteriorating infrastructure, growing customer expectations, new regulatory requirements, and a changing climate. Recognizing that "what gets measured gets managed," water utilities rely on performance indicators that are "actionable" to drive improvements in their operations.

Water loss control includes the efforts of water utilities to minimize NRW, which consists of real (physical) losses, largely leakage; apparent (nonphysical) losses that result in customer underbilling; and unbilled, authorized consumption. AWWA recommends that water utilities use a best-practice water audit method described in M36. AWWA's FWAS spreadsheet can be used to apply this method and a forthcoming version (6.0), is planned for release in 2020. AWWA also supports the use of annual water audits by water utilities in its Metering and Accountability Policy Statement (available at www.awwa.org). These tools and policies guide water utilities in quantifying water losses; evaluating cost-effective loss

control actions; and demonstrating to regulators, customers, and other stakeholders that utilities are responsible stewards of the valuable water resources and money they manage.

Thousands of water utilities have used AWWA tools to compile a reliable water audit and implement effective loss control practices; this approach is now required in several US states and at least one Canadian province. A large body of reliable water audit data has been collected from water utilities, and analysis of the data provides evidence of the types, extent, and costs of losses occurring in North America.

The traditional use of a single NRW percentage loss indicator, or "unaccounted-for" water percentage—which is imprecise—continues to bring more confusion than coherence to water loss assessments. This method arguably has never been successful in motivating sustained, measurable loss reductions. The AWWA water audit method includes an array of KPIs that represent both traditional and new, more insightful ways to evaluate NRW. While the current FWAS includes effective KPIs, it still uses two percentage indicators, although this is now considered to be a weakness by the WLCC.

With the development of version 6.0 of the FWAS, the WLCC determined that it was time to reevaluate its position on NRW KPIs. The committee believed that new KPIs were superior to percentages for water loss management and, in 2015, launched the Performance Indicators Task Force (PITF) to evaluate the acceptability of historically used KPIs and recommend the appropriate set of NRW KPIs to use going forward—i.e., AWWA's 2020 position.

The PITF included WLCC leadership and members representing a broad spectrum of water industry professionals and affiliations. It conducted research and evaluated traditional and contemporary NRW KPIs, which served as the basis of the 2020 position. The newly recommended slate of KPIs will appear in version 6.0 of the FWAS, the 2020 AWWA Benchmarking Survey, and the next edition of M36.

The decisions formulated by the PITF in guiding the new WLCC position include three recommendations (refined as position statements in the section titled "AWWA's 2020 Position"):

- Discontinue support for any percentage performance indicator, including the volumetric percentage performance indicator (VPPI), often expressed as an "unaccounted-for" water percentage, the financial percentage performance indicator (FPPI), and others structured as a percentage.
- Promote certain existing and two new KPIs—the loss cost rate (LCR) and normalized water losses—to use specifically in place of percentage indicators.

A large body of reliable water audit data has been collected from water utilities, and analysis of the data provides evidence of the types, extent, and costs of losses occurring in North America.

Nonrevenue water management has been historically hindered by the longstanding misconception that assessments can be reliably conducted using a single key performance indicator.

- Guide water utilities, regulatory agencies, and other stakeholders in using and interpreting AWWA's entire array of NRW KPIs in a manner that meets their situational needs.

The process leading to these recommendations is described next, along with guidance for implementing them. The WLCC's 2020 position is seen as the important next step in the evolution of water loss control advancement for the North American drinking water industry.

The Task Force Establishes KPI Criteria

The PITF established four criteria for the NRW KPIs advocated in AWWA's 2020 position. The KPIs should be

- technically rigorous, reflecting field observations and theoretical principles, without significant bias or influence from situational parameters;
- easily understood by a wide range of stakeholders, including water utilities, regulatory agencies, customers, elected officials, and the media;
- suitable for target-setting and monitoring of progress in loss reduction activities—i.e., they must be actionable; and
- suitable for the state of readiness of North American water utilities and regulatory agencies, recognizing that some water utilities will be new to water loss control and that regulatory agencies need straightforward ways to collect water audit data and loss control monitoring that can be readily implemented.

No KPI in the recommended suite is expected to satisfy all four of these criteria; however, they are all technically rigorous and suitable for the preparedness of North American water utilities and regulatory agencies. Some KPIs are specifically suited for setting loss reduction targets, while others are fit for benchmarking comparison, operational efficiency, or financial efficiency. Certain KPIs are expected to resonate with nontechnical stakeholders, while others have strong appeal for regulatory agencies. Most importantly, the AWWA water audit method features a full array of KPIs that, when applied collectively, provide a better understanding of

the occurrence of NRW and its costs in utility operations than what has been previously available. Loss control activities are reliably planned and conducted when using the full suite of NRW KPIs in the AWWA water audit method. This is significant because NRW management has been historically hindered by the longstanding misconception that assessments can be reliably conducted using a single KPI (percentage or otherwise).

The PITF knew the KPIs needed to be both technically astute and understood by a range of stakeholders. The task force began with an understanding that percentage indicators are technically weak because they are distorted by changing customer consumption levels, causing percentages to be easily misunderstood. Additionally, percentages are not actionable, so setting goals involving lower percentages does not easily translate into saving water, reducing production costs, or gaining revenue. Certain NRW KPIs must be actionable or able to be used for translating loss reduction efforts to measurable savings in water and money. In moving beyond percentage indicators, the drinking water industry will also move beyond the misconception that a utility's loss standing can be assessed using any single KPI. Like financial performance and drinking water quality, comprehensively assessing a utility's water loss requires multiple parameters and KPIs to objectively provide direction.

NRW KPIs must be applicable to the current state of readiness of water utilities and North American regulatory agencies to implement. However, because many water utilities are unfamiliar with AWWA methods and tools, KPIs and their implementation must be easily grasped by staffs at water utilities of all sizes, albeit with moderate training to understand the methods.

The features of the 2020 position will be included in version 6.0 of the FWAS and the next (fifth) edition of M36 (targeted for 2021). Incorporating the 2020 position into AWWA's key water loss control publications will support the drinking water industry for the next five years or so, but additional improvements in the water audit process and data collection software platforms are already being planned.

AWWA-Funded Research on NRW Performance Indicators

Current and new NRW KPIs were examined using the PITF's four criteria as described here and in the Technical and Educational Council (TEC) 2019 project report, *Assessment of Performance Indicators for Nonrevenue Water Target Setting and Progress Tracking*. Three tasks were requested of this research:

- Explore a list of KPIs to evaluate and control NRW, including those suited for setting water loss control targets.

● **FEATURE** Nonrevenue Water KPI Recommendations

- Analyze prospective KPIs using validated water audit data, including data from California and Georgia and an enhanced version of the AWWA Water Audit Data Initiative, known as the WADI Plus data set (see the Water Research Foundation's 2019 project 4695, *Guidance on Implementing an Effective Water Loss Control Plan*).
- Survey several US state and Canadian provincial regulatory entities that have implemented water loss control regulations and that document the key characteristics of their programs, including how they use NRW KPIs.

The core methodology of the research assessed each indicator for the four criteria, using a mix of quantitative and qualitative scoring. Technical rigor was assessed using the frontier analysis method, which predicts relative performance for utilities in a similar mathematical situation. For example, if an indicator measuring real losses is well correlated with real loss performance from the frontier analysis, that indicator is considered technically rigorous.

The final TEC project report presented a recommended set of NRW KPIs and a rationale for phasing in, or out,

AWWA 2020 Position on Nonrevenue Water Key Performance Indicators (KPIs)

Discontinued Support of KPIs

Type

Volumetric percentage performance indicator

Drawbacks

- Affected by changing levels of customer consumption
- Cannot distinguish between components of nonrevenue water: apparent and real losses, and unbilled authorized consumption
- Reveals nothing about water volumes and associated monetary values

Type

Financial percentage performance indicator

Drawbacks

- Unduly influenced by wide annual variation in total operating costs
- Apparent loss cost is set by the customer retail unit charge, which can vary widely

Newly Recommended KPIs

Type

Loss cost rate indicators

Benefits

- Marry the rate of losses (apparent or real) with the value of those losses
- Incentivize utilities to enhance water loss control interventions
- Provide a strong nonrevenue water assessment value at the utility level
- Express the impact of costs on a per-connection level
- Useful for regulatory agencies to flag utilities with very high values

Type

Normalized water losses (NWL) indicator

Benefits

- Allows utilities to track year-to-year losses
- Provides additional insight during years when either portion of NWL varies notably from the prior year

Figure 1

certain indicators. The research provided objective assessments of NRW KPIs and provided the foundation of the WLCC's new position.

AWWA's 2020 Position

Since 2003, AWWA has advocated using the NRW KPIs included in M36 and FWAS for water loss assessments and loss control planning. Informed by the TEC report and its member deliberations, the PITF recommended a new position on NRW KPIs, along with specific guidance on their use. Three primary changes to the KPIs were recommended (summarized in Figure 1):

- AWWA no longer supports any form of NRW percentage KPIs, including volumetric indicators such as water loss percentage indicators, "unaccounted-for" water percentages, and financial percentage indicators.
- AWWA supports the use of the LCR indicator, a new KPI expressed in value per service connection per year, with one expression for apparent losses and one for real (leakage) losses. These KPIs measure the negative impact of losses on a utility's finances.
- AWWA supports the use of the normalized water losses indicator, a new KPI expressed in volume per service connection per day. *Water losses* is the sum of apparent losses and real losses. It is meant to be used only as a high-level indicator and in tandem with the disaggregated normalized KPIs: normalized apparent loss (volume per service connection per day) and normalized real loss (volume per service connection per day).

Each of these changes is discussed further in the following sections.

AWWA's Discontinued Support of NRW Percentage Indicators

Percentages are problematic because their fractional components (numerator and denominator) can be unduly influenced by factors unrelated to water loss control activities. The basis for discontinuing support for them is twofold.

First, the KPI known as the volumetric percentage performance indicator (VPPI), often expressed as the "unaccounted-for" water percentage, is a misleading and unreliable measure of utility performance for three reasons: (1) VPPI is greatly affected by changing levels of customer consumption, (2) VPPI cannot distinguish the components of NRW (apparent and real losses, and unbilled authorized consumption), and (3) VPPI reveals nothing about water volumes and associated monetary values—the two most important factors in assessing a utility's water efficiency. Furthermore, percentage indicators like VPPI

are not technically rigorous because they can be significantly influenced by parameters unrelated to NRW.

It is important to note that AWWA recommends that water utilities, regulatory agencies, and other industry stakeholders discontinue use of a VPPI or "unaccounted-for" water percentage indicator.

Second is the financial percentage performance indicator (FPPI). This indicator has limitations as a result of similar undue influences on the numerator and denominator—in particular, wide annual variation in total operating costs (denominator), which are common for some water utilities as reported in AWWA's 2019 *Assessment of Performance Indicators for Nonrevenue Water Target Setting and Progress Tracking*. Also, the apparent loss cost—a component of the FPPI—is set by the customer retail unit charge (CRUC), which can vary widely because while some water utilities include sewer charges in the CRUC, many do not.

This KPI has been used formally in a regulatory context in a single US state (the only such use of this KPI known to the PITF), which uses it as both a performance tracking indicator and a target-setting indicator. By removing its support for the FPPI, AWWA recognizes that an alternative financial indicator is needed; the LCR KPI is offered for consideration by regulatory agencies because, as a KPI, it's superior to the FPPI. AWWA believes that water utilities should not employ the FPPI or any percentage KPIs in water loss assessments.

To this end, AWWA is removing all percentage indicators from its water loss publications and tools, including the next (fifth) edition of M36 and the next version (6.0) of its FWAS. AWWA instead recommends adding two alternative KPIs, which are described in the next sections (and summarized in Figure 2).

AWWA's Support of LCR

An alternative KPI is the LCR, mentioned earlier. Expressed in dollars per service connection per year, the LCR is a financial KPI, with one expression for apparent losses and one for real losses. The LCR indicates the financial impact of the respective losses to the utility and has public relations value by expressing annualized loss costs (operating cost and revenue) on a per-connection basis. It is derived from each corresponding normalized volumetric loss indicator expressed in volume per connection per day, by converting the volume unit to its value of loss, expressed on a yearly basis. This KPI marries the rate of losses (apparent or real) with the value of those losses as a cost rate of losses. Utilities with a high LCR incur high losses and/or high costs. On a broad level, high LCR values give a water utility good incentive to enhance their water loss control interventions.

Expressed in volume per connection per day, NWL is a high-level KPI that represents the combined volume of apparent and real losses occurring in the water utility on a per-connection basis. The NWL metric allows utilities to track their year-to-year losses and provides additional insight during years when either portion of

AWWA recommends that water utilities, regulatory agencies, and other industry stakeholders discontinue use of a VPPI or “unaccounted-for” water percentage indicator.

NWL (apparent or real normalized loss rate) varies notably from the prior year. NWL should not be used as a stand-alone KPI, but in combination with the apparent and real loss normalized indicators. Also, as a high-level indicator, NWL is not actionable because its components include water that is physically lost (real losses) and water that is not physically lost but under-recorded (apparent losses). Thus, NWL should not be used for target-setting. Instead, targets can be set using the normalized apparent and real loss indicators. NWL is best used in the data validation process by helping broadly explain year-to-year changes in apparent and real loss volumes and provide a buffer against inordinate uncertainty in either of these volumes.

NWL is new and has not yet been employed extensively. As a combined version of the normalized apparent losses and normalized real losses indicators, NWL is subject to the same influencing factors as those KPIs. AWWA believes that NWL—used for high-level trending in combination with other KPIs—adds value to water loss assessments.

Incorporating the New KPIs in the Free Water Audit Software

Concurrent with the PITF's efforts to update its position on NRW KPIs, the WLCC Software Subcommittee worked to develop version 6.0 of the FWAS. The PITF coordinated with the subcommittee to include LCR (apparent and real forms) and NWL in version 6.0 of the FWAS. Version 6.0 will include many additional improvements.

Guidance for NRW KPI Implementation

Since the launch of the FWAS in 2006, Georgia, California, Hawaii, and the province of Quebec have required utilities to use the AWWA water audit method and the FWAS as the data collection tool. These initiatives have formal programs that include training for water utilities in the water audit process, including data collection, validation, and analysis. The data quality of these programs is distinctly higher than programs that accept self-reported data from water utilities. Regulatory agencies requiring water audit data collection are urged to employ the AWWA FWAS and provide training for utility auditors and formal validation of the reported water audits. Several states have leveraged set-aside funds from their state revolving fund programs to pay for training and validation.

The FWAS is used with lesser requirements in many other states and agencies, including Tennessee, New Mexico, Colorado, and the Delaware River Basin Commission, with pilot projects occurring in at least another six states. Data from thousands of water audits that were compiled using the FWAS are now available, and analysis of the data has provided deeper understanding of utility water efficiency than historic approaches using only a single percentage indicator. Additional water regulatory agencies are expected to adopt requirements for the AWWA water audit method because it enables more rational assessments, improved NRW reduction tracking, and benchmarking among water utilities. With a suite of effective KPIs available in the AWWA tools, agencies can use appropriate combinations to meet their water efficiency objectives. Table 1 describes the KPIs of the 2020 position, along with their suitability for specific purposes and their limitations.

Benefits for the Water Industry

The water industry's approaches of the past 60 years that have relied on imprecise, “unaccounted-for” water percentages have not been successful in motivating measurable loss reductions. Consequently, losses have been increasing in some systems as a result of deteriorating infrastructure (distribution system piping and customer water meters), increasing costs, and other factors. AWWA has advanced water auditing and loss control technologies considerably over the past 20 years, and it believes that these newer approaches are improving water utilities' ability to assess their water loss control standing, plan and execute effective loss reductions, and communicate this progress to stakeholders and customers. The improved outcomes for society include improved

● **FEATURE** Nonrevenue Water KPI Recommendations

management of water resources; improved utility operations and finances; consistent reporting and workable planning for loss control activities; and better understanding of water utility performance by

customers, the media, elected officials, funding agencies, and other stakeholders.

Multiple benefits are available to drinking water utilities via effective water loss control. It's time for

2020 AWWA Water Audit Method Outputs and Key Performance Indicators: Uses and Limitations

Indicator	Description	Suitable Purposes	
		Assessment	Benchmarking
Attribute			
Apparent loss volume	Calculated by FWAS	✓	
Apparent loss cost	Calculated by FWAS	✓	
Real loss volume	Calculated by FWAS	✓	
Real loss cost	Calculated by FWAS	✓	
Unavoidable annual real loss	Calculated by FWAS	✓	
Volume			
Normalized apparent Losses (volume/connection/day)	Strong and understandable indicator for multiple users	✓	✓
Normalized real losses (volume/connection/day)	Strong and understandable indicator for multiple users	✓	✓
Real losses (volume/ pipeline length/day)	Strong and understandable indicator for use by utilities with low connection density	✓	✓
Normalized water losses (volume/connection/day). New KPI	Strong and understandable indicator, suitable for high-level performance measurement	✓	
Real losses by pressure (volume/connection /day/pressure unit)	Robust, specialized indicator; technical rigor may be influenced by network materials	✓	✓
Infrastructure leakage index	Robust, specialized ratio KPI; can be influenced by pressure and connection density	✓	✓
Value			
Apparent loss cost rate (value/connection/year). New KPI	Indicators with sufficient technical rigor; provide the unit financial value of each type of loss, which is very useful for planning and assessment of cost efficiency of water loss reduction and control interventions and programs	✓	
Real loss cost rate (value/connection/year). New KPI		✓	
Validity			
Data validity tier ^a	Strong indicator of water loss audit data quality if data have been validated; tier provides guidance on priority areas of activity	✓	✓

FWAS—AWWA Free Water Audit Software

^aData validity tier is a new term that will appear in Version 6.0 of the FWAS (2020 release) and is a band-type grouping of data validity scores (DVS): of audit reliability.

DVS should not be used to quantitatively indicate accuracy for the audit outputs.

Table 1

additional water utilities and regulatory agencies to follow the example of the water utilities and state/provincial regulatory agencies that have embraced AWWA's water audit method.

Improved Water Loss Monitoring

AWWA has carefully investigated existing and new NRW key performance indicators and has recommended an updated set of KPIs for water utilities, regulatory agencies, and

Target-Setting	Planning	Tracking	Uses and Limitations	Principal Users
		✓	Assess loss level	Utilities, regulators
		✓	Assess loss cost level	Utilities, regulators
		✓	Assess loss level	Utilities, regulators
		✓	Assess loss cost level	Utilities, regulators
		✓	Reveal theoretical technical low level of leakage	Utilities, regulators
✓	✓	✓	Used for performance tracking and target-setting	Utilities, regulators, policy makers
✓	✓	✓	Used for performance tracking and target-setting	Utilities, regulators, policy makers
✓	✓	✓	Data collection and assessment of systems with low connection density	Utilities, regulators, policy makers
		✓	High-level indicator for trending analysis; not appropriate for target-setting or benchmarking	Utilities, customers
	✓	✓	Data collection and assessment of pressure level	Utilities
		✓	Benchmarking after pressure management is implemented	Utilities
	✓	✓	Data collection and assessment on AWWA indicators or contextual parameters to use in conjunction with loss cost rates	Utilities, regulators, customers
	✓	✓	Assess caliber of data inputs of the water audit	Utilities, regulators, customers
	✓	✓	Assess caliber of data inputs of the water audit	Utilities, regulators

Tier I: DVS = 0-25; Tier II: DVS = 26-50; Tier III: DVS = 51-70; Tier IV: DVS = 71-90; Tier V: DVS = 91-100. The data validity tier is a broad indicator

Multiple benefits are available to drinking water utilities via effective water loss control.

other water industry stakeholders. Of particular note is the recommendation to discontinue support for percentage indicators, which are known to be imprecise and misleading. AWWA advises water industry stakeholders to stop using percentage indicators and embrace those existing and new performance indicators recommended by AWWA. This development will greatly improve the ability of drinking water utilities to identify, quantify, and value water losses, as well as to target actions to advance the efficiency of water supply operations and management of water resources. 💧

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AWWA Resources

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